What's Driving Natural Gas into Transportation? Cities





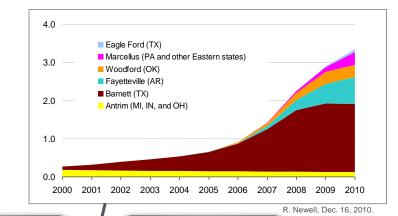
Natural Gas for Transportation Roundtable July 19, 2012 Appleton, WI

Marianne Mintz **Argonne National Lab**

The US is awash in natural gas (NG)





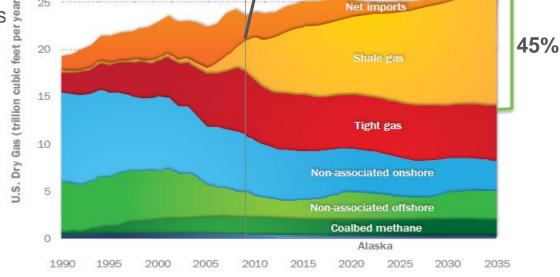


Projections

Photo courtesy of American Clean Skies Foundation

U.S. production of natural gas

- Uncertain environmental implications of new technologies
- With low NG prices, much current production shifted to wet gas & oil
- Potentially large but highly uncertain CH₄ emissions from NG production



2009

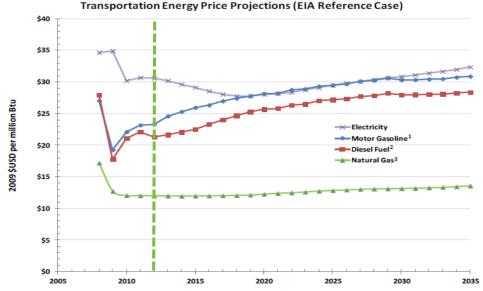
History



Key drivers for NG in transportation



- ✓ Availability of NG supplies
- ✓ Price spread between petroleum & NG
- ✓ Availability of NG vehicles
- ✓ Availability of NG stations/fueling



- 1 Sales weighted-average price for all grades. Includes Federal, State, and local taxes.
- 2 Diesel fuel for on-road use. Includes Federal and State taxes while excluding county and local taxes.
- 3 Compressed natural gas used as a vehicle fuel. Includes estimated motor vehicle fuel taxes and estimated dispensing costs or charges.

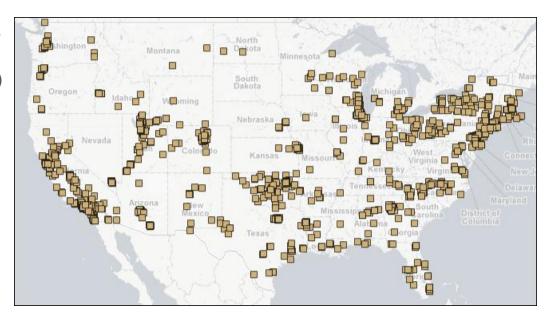
- CWI & Doosan produce big HD OEM engines (9 L ISLG and 15 L HPDI; 11 L GK12)
- CWI planning ISX12 G intro in 2013
- Navistar/ESI introducing 7.3 L
- Many conversions (GM & Ford "CNG ready" HD engines & LD fleet products) through partnerships
- Westport partnering with GM on future products
- Only Honda sells OEM cars in US.
 Will Toyota, Audi, Chrysler, Ford?
- Chrysler & GM introducing bi-fuel pickups in late 2012
- Vehicle price premiums expected to drop with volume; currently 1-5+ year payback, depending on use

Fueling infrastructure is coming....



Current counts and announcements

- 1047 CNG and 43 LNG stations in operation (vs. >120,000 petroleum stations)
- Station counts rose >17% in past year
- Nearly half (488 CNG & 23 LNG) public
- Clean Energy building "America's Natural Gas Highway", with 150 LNG stations at Pilot Flying J Travel Centers
- Shell & Travel Centers of America adding 200 LNG fueling lanes to 100 stations;
 Shell Canada partnering with Flying J
- ~130 new CNG stations assisted by ARRA/ Clean Cities & other government sources.
 Some (Fair Oaks, IN, DeKalb, GA) RNG
- Questar adding 10-12 CNG installations at C-stores, gasoline stations
- Shale gas producers (Encana, AGL, Chesapeake, etc.) converting fleets and building stations





Alternative Fueling
Station Locator
Find alternative
fueling station locations.



Total Stations Count Find the number of fueling stations in the U.S. by fuel type.



Mobile Alternative
Fueling Station Locator
Find alternative fueling
stations on your mobile device.

http://www.afdc.energy.gov/afdc/

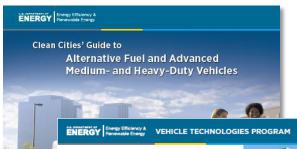
NG is part of the "all of the above" strategy



- ARPA-E funding for low-cost home refueling (13 awards, ~\$30 m)
- Clean Fleets Partnership: 20 fleets committed to adopt alt-fuels, advanced vehicles, petroleum reduction plans
- Clean Cities supporting:
 - National Community Deployment Challenge: a competitive grant program emphasizing deployment at scale and with economic sustainability. Participating communities to meet competitive goals and serve as national leaders for technology deployment models to be replicated elsewhere.
 - JOBS NG (JOBS and economic impacts of natural gas) model to estimate employment impacts of NG vehicles, fueling and fuel supply.
 - Life cycle analysis of shale gas and natural gas: see http://greet.es.anl.gov/publication-shale_gas
 - Natural Gas Vehicle Technology Forum: see
 http://www1.eere.energy.gov/cleancities/natural_gas_forum_meeting_oct12.html

Resources





Natural Gas Basics

Natural gas powers more than 100,000 vehicles in the United States and roughly 12 million vehicles worldwide. Natural gas vehicles (NGVs) are a good choice for high-mileage fleets—such as buses and taxis—that are centrally fueled or operate within a limited area. The advantages of natural gas as an atternative fuel include its domestic availability, widespread distribution infrastructure, low cost compared with gasoline and diesel, and clean-burning qualities.



dominantly methane (CHA). Because it is ago, it must be stored onboard as which in either a compressed gaucous or lisque-flet state. Compressed natural gas (CNO) is typically stored in a tank at a pressure of 3,000 to 3,500 younds per square stored and stored in its liquid place at cooled and stored in its liquid place at a cooled and stored in its liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in the liquid place at a cooled and stored in

How and where is natural gas produced

Shuttle

Refuse

Tractor

Vocatio

and distributed?

Natural gas is down from wells or extracted in conjunction with crude oil production. Bireman, at renewable form of natural gas, is produced from downlying capies intericials, such as westerning control of the confidence of the

How Is natural gas used? Natural gas accounts for about a quarter of the energy used in the United States. About one-third goes to residential and commercial uses, such as heating and cooking; one-third to industrial uses; and one-third to electric power production. Only about one-tenth of 1% is used for transportation fuel.

Is natural gas safe for use In vehicles?

the latest new vehicle offerings, also so the AFDC's light-duty and heavy-duty

How do NGVs work?

NGVs operate in one of three modes

NGVs run on only natural gas. Bifuel NGVs can run on either natural gas or

gasoline. Dual-fuel vehicles run on natural gas and use diesel for ignition assist.

Light-duty vehicles typically operate in dedicated or bifuel modes, and heavy-

duty vehicles operate in dedicated or dual-fuel modes.

sure natural gas from the storage tank to the engine while reducing the pressure

of the gas to the operating pressure of the engine's fuel-management system. The natural gas is injected into the

engine intake air the same way gasoline is injected into a gasoline-fueled engine. The engine functions the same way as a gasoline engine. The fuel-air mixture is compressed and ignited by a spark plug

and the expanding gases produce rotational forces that propel the vehicle.

On the vehicle, natural gas is stored in tanks as CNG, or in some heavy-duty

sted, bifuel, or dual-fuel. Dedicated

Yes. NGVs meet the same safety standards as gaseline and diesel vehicles and also meet the National Fire Protection Association's (NFPA) NFPA 52 Vehicular Facil System Code. Natural gas has a narrow flammability range and, because it is lighter than six, dissipates quickly if released. NGV facil tanks are strong and extremely puncture resistant.

What NGVs are available?

A wide variety of new, henry-daity NOVE, new available. The Honda Civic OX is the only light-dary NOV available from a U.S. original equipment measurfacture (DEM). Consumers and fleets sho have the option of conomically and reliably converting existing light- or heavy-duty goodine or diseason spage in the Vehicles See the Conversion using certified installers. See the Conversion page in the Vehicles of the Conversion page in the Vehicles of the Conversion page in the Vehicles (Web site as ward conorgygors.)



www.cleancities.energy.gov - April 2010

Clean Cities

Publications

- Natural Gas Basics
- Guide to Alternative Fuel and Advanced Medium- and Heavy-Duty Vehicles
- Guide to Alternative Fuel Commercial Lawn Equipment
- Clean Cities 2012 Vehicle Buyer's Guide
- Business Case for CNG in Municipal Fleets
- Clean Cities Vehicle and Infrastructure Cash-Flow Evaluation (VICE) Model to evaluate the return on investment and payback period for natural gas vehicles and fueling infrastructure
- Alternative Fuel Price Report

www.cleancities.energy.gov/publications

Resources



Industry

- Clean Vehicle Education Foundation (funded by Clean Cities, States, and industry)
 - Coordinates Transit Users Group, School Bus Users Group
 - Produces TUG Bits newsletter
 - Investigates accidents and notifies other users of corrective actions
 - Provides scholarships for cylinder safety courses
 - Conducts studies
 - Teaches Fleets about NGV issues at "The Compelling Case for Natural Gas Vehicles Workshops"
- Gas Technology Institute
 - Cylinder testing
- Private Sector Training Firms

Academia

- National Alternative Fuels Training

 Consortium (funded by U.S. DOE

 and member schools)
 - Network of national training centers, consisting of universities, community colleges, and secondary schools, located across the United States
 - Train the trainer programs for technicians on Liquefied Natural Gas Vehicles, Light-Duty NGVs Heavy-Duty Gaseous Fuel Applications, and Compressed Natural Gas Vehicle Fuel Systems Inspections

Websites and Contact Information



Clean Cities Website www.cleancities.energy.gov

Clean Cities Coordinators
www.afdc.energy.gov/cleancities/progs/coordinators.php

Alternative Fuels & Advanced Vehicles Data Center www.afdc.energy.gov

Clean Vehicle Education Foundation
http://www.cleanvehicle.org/
http://www.cleanvehicle.org/workshop/kansascity.shtml

Marianne Mintz

Argonne National Laboratory 630-252-5627 mmintz@anl.gov

Marcy Rood Werpy

Argonne National Laboratory 217-362-9844 mroodwerpy@anl.gov

Lorrie Lisek

Wisconsin Clean Cities 219-765-4776 lorrie.lisek@WICleanCities.org